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ABSTRACT

As an aid to contemporary research, this paper examines historical ideas about young children's use of strategies for memorization and the transfer of such strategies to different contexts. Discussion focuses on (1) current approaches to inducing transfer of strategies; (2) Thorndike and Woodworth's concept of identical elements; (3) Gestalt psychology and transfer by insight; (4) a comparison of Gestaltists' and Thorndike's positions on teaching the concept of area; (5) contributions of Thorndike and the Gestaltists to present transfer research; and (6) past insights and future directions. Inspection of the controversy between connectivists and Gestaltists suggests that their differences have been overemphasized, and that similarities between the two positions can inform the present view of the developmental transfer literature. Moreover, the differences in the two approaches suggest different, but complementary, ways of instructing children to transfer problem-solving techniques to new contexts. (RH)

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Children's Generalization of Strategies: An Historical Perspective on Transfer[1]

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[1]Paper presented at the meetings of the Society for Research in Child Development, Baltimore, April, 1987. Send comments, correspondence, and requests for copies to: Brian D. Cox, Department of Psychology, Davie Hall 013A, University of North Carolina, Chapel Hill NC 27514.

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This paper had its origins in our attempt to understand young children's use of strategies for memorization and the transfer of these procedures to many different contexts. As we studied the present literature, we found that contemporary approaches to the problem of transfer are not new, but show certain parallels with historical views on the subject. The particular correspondences we found were surprising to us, however, and perhaps more importantly, the ideas of earlier psychologists also seemed useful in enriching our current perspective on the transfer of mnemonic techniques. Thus, in this paper, we examine historical ideas on transfer as an aid to contemporary research.

Current Approaches to Inducing Transfer of Strategies

Strategies such as rehearsing many items together, sorting words into meaningful semantic groups, or generating images are essentially problem solving procedures that help children to reach the goal of remembering. In current research on children's memory, there seem to be two approaches to the study of transfer. In the first approach, children who typically do not use a memory strategy spontaneously are trained specifically in the steps required to perform a strategy; for example, an 8-year old may be instructed in how to sort items into meaningful groupings. Then, sometimes immediately following the training task, sometimes after a delay, transfer is assessed. Typically, the children are placed in a nearly identical situation, with the substitution only of a new stimulus list, and they do not frequently elect to continue using the strategy (see Brown, 1978 for review; see also Bjorklund, Ornstein, & Haig, 1977; Ornstein, Naus, & Stone, 1977).

This approach of focusing on the similarity of the training and transfer situations does not necessarily promote transfer.

In the second approach to transfer, subjects are trained to focus directly on how the use of a strategy may facilitate reaching the goal of remembering (for reviews, see Campione, Brown, & Ferrara, 1982; Pressley, Borkowski, & O'Sullivan, 1984). In these studies, children are instructed in self-monitoring techniques that permit them to use feedback from the results of recall to evaluate the use of a particular strategy. These techniques thus direct the subject to consider how various aspects of the training and transfer situations may be similarly related to the memory goal. As a result, this approach has been moderately successful in inducing transfer whereas the first approach has not.

In evaluating the pattern of failures and successes in this research, we reached the conclusion that transfer cannot be explained in terms of mere similarity or difference between the training and transfer situations. Rather, an explanation that emphasizes the goal-directed nature of children's performance in memory experiments may be more useful. At this point, it occured to us that we rediscovered the classic associationist-Gestaltist debate that was argued many years ago. On one side, following Thorndike and Woodworth (1901 a,b,c), the connectionists argued that transfer was governed by the number of identical elements present in the training and transfer tasks. In contrast, the Gestaltists had suggested that the perceptual system was predisposed to treat stimuli wholistically, rather than as collections of elements. Moreover, the perception of stimuli was governed to some

extent by the function that they served in reaching the goal of a particular task; that is, things could be perceived differently depending on the purpose for which they are to be used (Koehler, 1929; Wertheimer, 1945/1959). When we looked at this controversy, however, we discovered that Thorndike and the Gestaltists did not differ nearly as much as we had assumed, but rather that their differences had been overemphasized because of the historical conflict between the positions. We think that an examination of the similarities in the two positions can inform our present view of the developmental transfer literature. Moreover, the differences in their approaches suggest different, but complementary, ways of instructing children to transfer problem-solving techniques to new contexts. With this in mind, we now turn to the history of the two positions.

Thorndike and Woodworth's Identical Elements: Practical Associationism

Thorndike and Woodworth's original conception of transfer was put forth as a challenge to the "mental discipline" theory prevalent in educational psychology at the turn of the century. According to this view, the operation of the mind can be improved "in general," and difficult subjects, such as Greek or Latin, or geometry, were viewed as kinds of mental exercise that would give students the ability to think clearly and deeply. According to one college president who exemplified this position: "The mind takes fiber, facility, strength, adaptability, [and] certainty of touch....The college should give elasticity of faculty and breadth of vision so that [students] shall have a surplus of mind to expend (Wilson, 1902; in Thorndike, 1913, p. 363)." Mental discipline psychology suggested that training on one task would promote

the performance on another through an increase in capacity or flexibility, so that a transfer task would be trivial if an initial training procedure had been performed properly.

Thorndike disagreed strongly with this viewpoint, calling it a theory which likens ability to "amounts of something which can be stored in a bank, to be drawn on at leisure (Thorndike, 1903, p. 85)." Instead, Thorndike and Woodworth's experiments were set up to prove that the transfer of ability to new tasks was not due to the exercise of general faculties, but rather as a function of the amount of similarity between the features of the two tasks. In one of the original experiments, for example, adult subjects were trained to estimate the size of rectangles varying between 10 and 100 square centimeters, and then tested on the estimation of the areas of triangles of the same sizes, or the estimation of rectangles in a different range of sizes. Instead of performing just as well on the transfer task as on the original trained task, as would have been predicted by the mental discipline theory, subjects performed less than half as well on the new tasks (Thorndike & Woodworth, 1901a,b,c; Thorndike, 1913).

Thorndike and Woodworth attributed the improvement, or lack of it, to the number of "identical elements" common to the training and transfer tasks. However, it should be noted that the commonality was not just based on stimulus elements, as the theory was later interpreted by behaviorists; in contrast, they viewed similarity in cognitive terms, focusing on similar mental actions or habits related to stimuli. They give the following example and definition: "We may say 'I tend to judge this with a minus error' and the habit of saying this may be beneficial

in all cases. The habit of bearing this judgement in mind or of unconsciously making an addition to our first impulse is thus an identical element of both functions (Thorndike & Woodworth, 1901a, p. 256)."

Thorndike's elementarism, so emphasized by subsequent behaviorist treatments, began as a reaction to an overly general theory of pedagogy, rather than as a behaviorist's reaction to subjectivism. Thorndike did share the behaviorists' reliance on careful measurement, and was always extremely cautious about ascribing cognition to animals. But Thorndike also felt that human behavior was selective in that the first step in forming an association was to select the stimulus out of the stimulus field and then to choose the response to connect with it. The stimulus was never a "given" to Thorndike; his view of transfer was based on extracting "essential elements" of many separate stimuli from what he called the "gross total stimulus situation" (Thorndike, 1906).

Gestalt Psychology and Transfer by Insight

The position of the Gestalt psychologists on transfer and insight began in part as a reaction to the elementarism of the connectionists, which, in their view, included both Thorndike and the Watsonian behaviorists. Wolfgang Koehler (1925; 1971) had applied the concepts of field theory physics to his observations of problem-solving abilities in apes. Koehler argued that behavior is only understandable in terms of total complexes of responses in relation to the natural or laboratory environment, rather than as simple stimulus-response sequences. To Koehler, behavior had meaning only at a more molar level. He had found that his apes would struggle to solve a problem for a certain period of

time, and then at some point, a qualitative change in their behavior would occur, such that they would no longer make errors on the task. Moreover, the apes could often transfer their knowledge to variations of the task on which they had been trained, again performing without error. This was insight learning, based on recognition of wholistic and functional aspects of the stimulus field. Koehler felt that to proceed to analyze behavior in smaller and smaller parts, a tendency he had seen in both behaviorism and structuralism, might result in a valid explanation of neuromuscular relationships, but not of the structure of behavior.

The Gestaltists believed, as Thorndike did, that stimuli operate on behavior indirectly, through structures imposed upon them by a perceiver. But for them, part of this structure lay in the tendency of the nervous system to treat stimuli as wholes that would be functionally useful for an organism, and part was based on a past history of perceiving the world in this wholistic way. Because of the bias of the system to perceive stimuli at a more molar level, meaningful relationships among stimuli are almost immediately available in the stimulus field, regardless of whether or not an individual reflects on these relationships; any episode in which a relationship <u>is</u> consciously recognized was, for the Gestaltists, an experience of insight. In contrast, for Thorndike, the ability to be selective allows an individual to apprehend the essential features common to a number of stimuli, but connections among these abstracted features are developed and strengthened through continual practice--i. e., through habit, not discovery.

An Example of the Two Approaches: Teaching the Concept of Area

These similarities and differences can best be illustrated by comparing the two positions on a particular problem involving transfer: the teaching of the concept of area, a subject addressed both by Gestalt psychology's founder, Max Wertheimer, and by Thorndike. Following these examples, we will discuss what these approaches offer to the present study of the development of memory strategies, and problem solving in general.

To Wertheimer (1945/1959), the object of teaching was to guide children toward the discovery of relations that are constrained both by the perceptual structure of a situation and by the goal of the problem-solving task in that situation. Thus, for example, in teaching how to calculate area, the teacher may show a large and a small rectangle, as in this first slide, and ask "How can we find which is

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Slide 1

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bigger?" If there is no answer, Wertheimer suggests that the instructor move on to examples in which the child can find the relevant structure relating to his or her life, such as a story about finding the differences in the sizes of farms or neighborhoods. One might also cut a piece of cardboard the size of the difference, or measure with blocks, showing how the cardboard fits, or how many blocks are needed, as shown in the next slide. The rectangle can then be divided up into equal

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Slide 2

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portions for measurement, as shown in this next slide, and the formula, through counting, can be derived. Wertheimer does not teach the

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Slide 3

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actual operations involved in area calculation. Rather, he guides the child's attention to the relationships among the figures, so that these procedures for calculation can be discovered and constructed.

Once the child can calculate the area of a rectangle, it is possible to examine transfer to problems involving a paralellogram, using a cardboard figure, as is shown in the next two slides. Instead of giving only verbal instructions involving measurement, one might cut off the triangle part at one end of the parallelogram, and then place it

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Slides 4 and 5

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where it "fits" into the rectangle. Again, if the child does not understand, Wertheimer suggests that the teacher connect the abstract geometric example to one in "real life." Following this step, other examples are given, such as those in the next slide, that are more general abstractions of the "missing piece principle." An important feature of such training is to allow the child to examine figures

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Slide 6

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for which the principle will definitely not work, as seen in the next slide, so that he or she may determine the limits of the application of the strategy. Finally, repetition and practice are added, but the

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Slide 7

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practice must be with several types of figures mixed together, so as to insure that individual response patterns are not fixed as isolated habits to a particular stimulus, but are established as responses relating to the entire structural configuration.

Again, throughout the entire teaching process, which is essentially as much a construction of a Gestalt as a discovery of one there already, Wertheimer deliberately avoids giving instructions, and permits the child to keep open the choices for solution of the problem. The child is encouraged to avoid applying a particular operation until a broad sample of appropriate and inappropriate exemplars has been given, avoiding the strengthening of particular habits over ones useful in the whole situation.

Thorndike's contrasting approach to finding area is taken from his 1923 Psychology of Arithmetic. He notes that the common method for teaching area, as taught in the classroom in his day, was to provide a rectangle divided into square inches, as in this slide we have seen before. The child's attention is directed to counting the number of

squares in the rows and columns, and then to multiplying to get the

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Slide 8 (same as 3)

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result. He notes that it is better to hide the square units, as in this next slide, because the concrete rows and columns distract attention

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Slide 9

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from the essential thing to be learned. This is not that "...x rows one square wide, y squares in a row will make xy squares in all..." but that "...by using proper units and the proper operation the area of any rectangle can be found from its length and width (Thorndike, 1923, p. 258)." Thorndike argued that if one uses addition to illustrate multiplication, the bonds of the addition responses in this situation will later have to be broken when multiplication is learned, thus causing confusion. The use of multiplication directly, by contrast, leads to the a flexible understanding of the calculation of area, in that multiplying is more functional than addition for fractional areas, and it also implies the concept that 1 X 1 = 1/2 X 2 = 1/3 X 3. Counting is to be used for verification only after the answer is obtained.

The insistence on making bonds that will not have to be broken later is, in essence, a recognition, similar to that of the Gestaltists, that there are certain constraints to learning and transfer situations,

based on perception or prior knowledge. Connections are built up in personal history, but these connections do not operate independently of one another. The area example shows that Thorndike believed that the "bonds" among elements in the operation of multiplication, as well as the bonds between the process of multiplication and the contexts in which it will be used, should not be formed one at a time in a piecemeal fashion, but as a consistent body of knowledge. However, Thorndike's approach seems somewhat more limited than Wertheimer's, because the focus is on teaching the actual operation, rather than on leading the student to discover these techniques and their relationships to the stimulus situation.

Contributions of Thorndike and the Gestaltists to Present Transfer Research

This historical examination of issues in transfer has been fruitful in a number of ways. First, we were able to overcome some of our misconceptions about Thorndike and the Gestaltists. Thorndike's theory of identical elements was considerably more cognitive in character than subsequent treatments of his work had led us to believe, and his approach to transfer in general involved a detailed appreciation of the importance of situational constraints. In this, he is closer than we had thought to our present, more cognitive, approach to transfer research. But the functional, wholistic approach of the Gestaltists seems more compatible with the approach that has found most success in the literature, as exemplified by those studies that focus on the goals and results of a strategy using feedback from recall and self-monitoring

(e.g. Lodico, Ghatala, Levin, Pressley, & Bell, 1983; Ghatala, Levin, Pressley, & Goodwin, 1986).

Second, we found that the Gestaltists' method of discovery may make an important contribution to present research. With this method, a child is encouraged to look for a solution among many possibilities, and while doing so, he or she may learn much about the situations in which particular stategies are and are not useful. Experience with the type of open problem presented by Wertheimer may lead to longer lasting and wider ranging strategy success than even that obtained as a result of instruction in monitoring and feedback procedures. In many ways, this view is consistent with the ideas expressed in the "discovery learning" literature (e. g. Bruner, 1961; Shulman & Keislar, 1966), which suggests that when children are required to search for solutions to problems, they aquire generalized problem-solving skills rather than isolated answers or facts.

Past Insights and Future Directions

We are certainly not the first to have noted that there are strong similarities as well as some differences between the work of Thorndike and the Gestaltists. L.S. Vygotsky noted many similarities, but in his analysis he offers a caution of particular importance to developmentalists. In his prefaces to the Russian translations of Koehler's works, (Vygotsky, 1934/1982) we have found that Vygotsky praised Koehler for breaking away from what he perceived to be Thorndike's "atomism" to consider functional wholes. Indeed, Koehler's view of the irreducible nature of behavior influenced Vygotsky considerably (Vygotsky, 1986). But Vygotsky criticized Koehler for

considering the structure of perception mainly at a particular point in time. Because Koehler did not consider development and the dynamic changes in thought accompanying development, Vygotsky saw his approach as static "molecularism." There is some indication that Vygotsky thought Wertheimer's analysis of guided discovery in an individual transfer session to be useful (see Vygotsky, 1986, pp.204-205). In fact, Wertheimer's example given above is very similar to an interaction focused on a task in a child's zone of proximal development. But in Vygotsky's view, we also need to take into account the developmental history of a child. Transfer can be explained only when the process of interaction between experimenters and subjects is studied within the context of the continuous changes of development. The approaches of Wertheimer and Vygotsky, taken together, can help us to construct such an explanation.

In this presentation, we have suggested that the study of transfer can be enriched by viewing this problem in its historical context. Present research is always influenced by the work of earlier theorists, and the area of development of transfer abilities is no exception. But history can also erase or distort some ideas that, if seen in their original fresh presentations, can become the impetus for new views of our "old" current problems. We have seen that history has relevence for the developmental transfer literature; it should be so for the rest of psychology as well.

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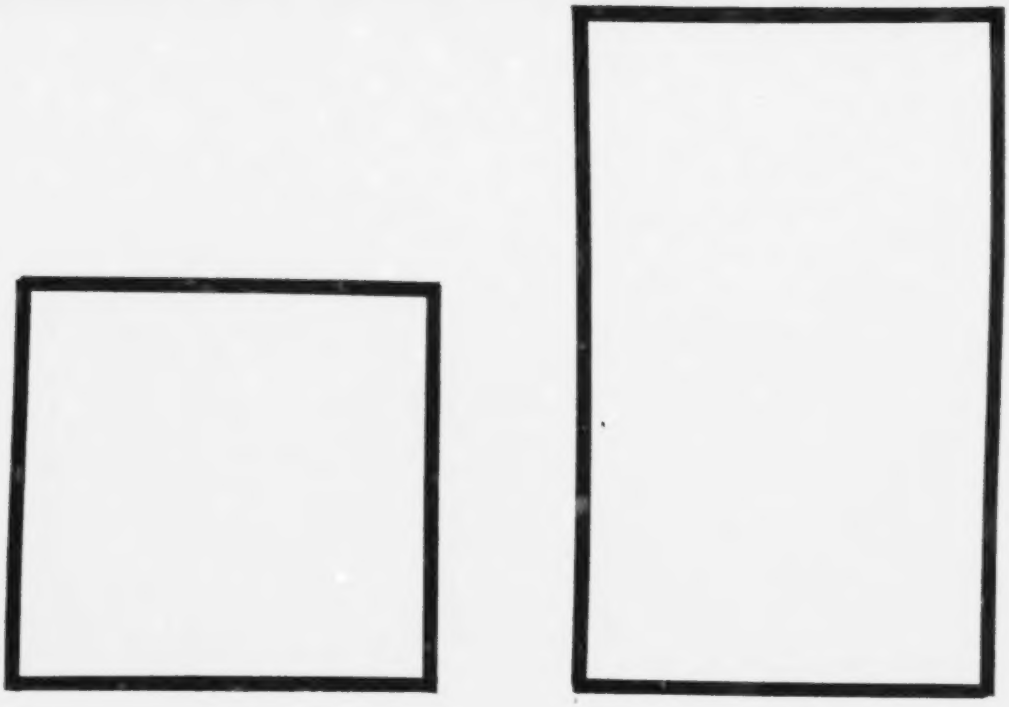

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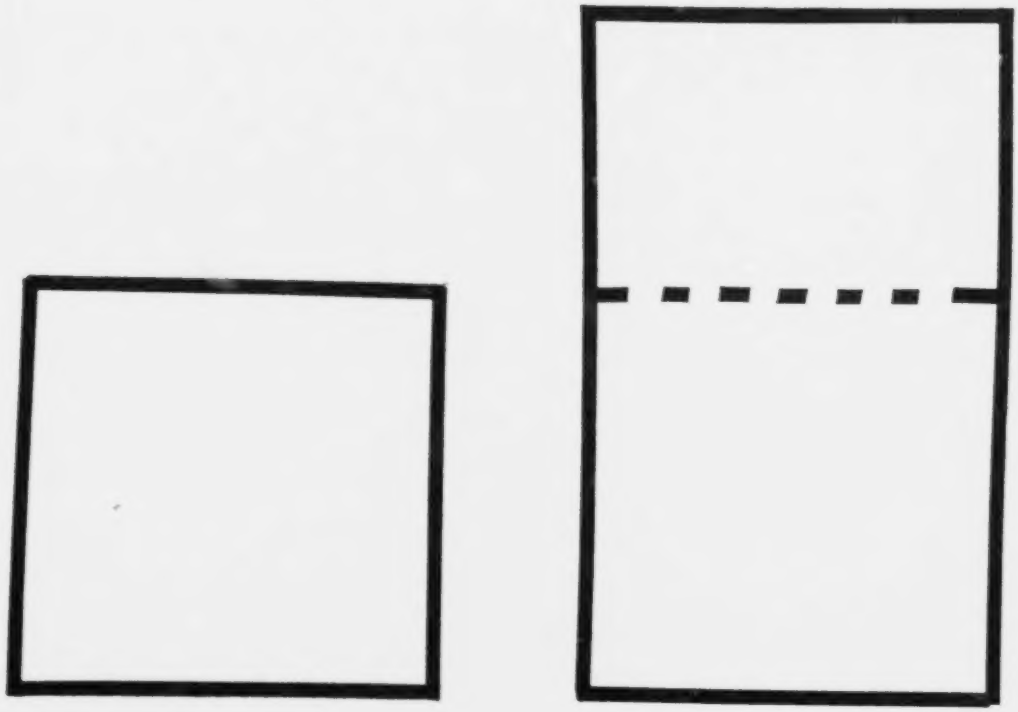

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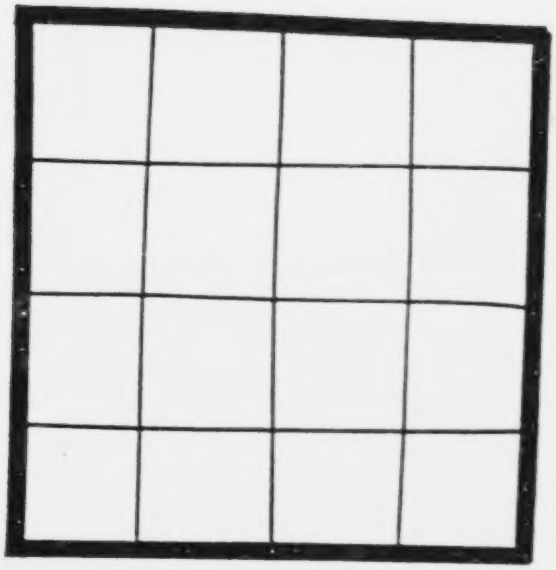

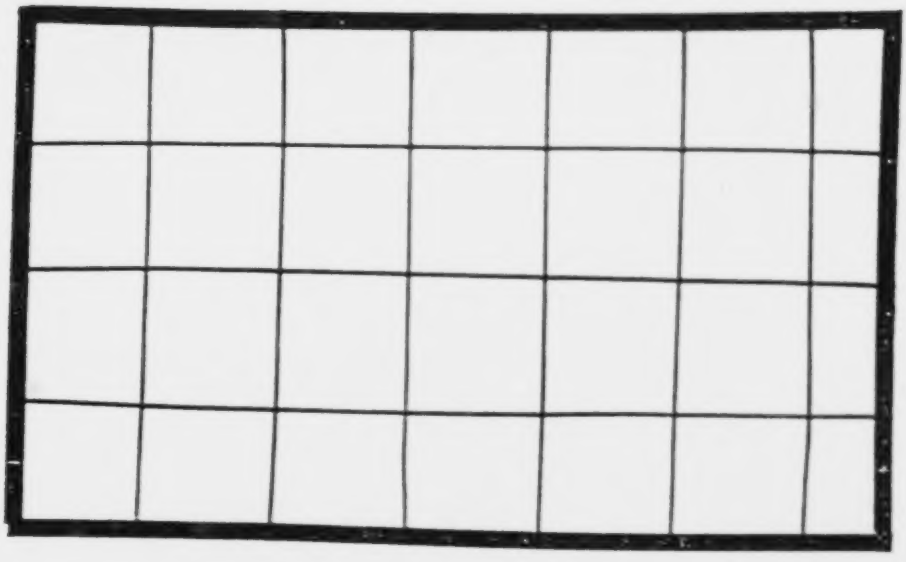

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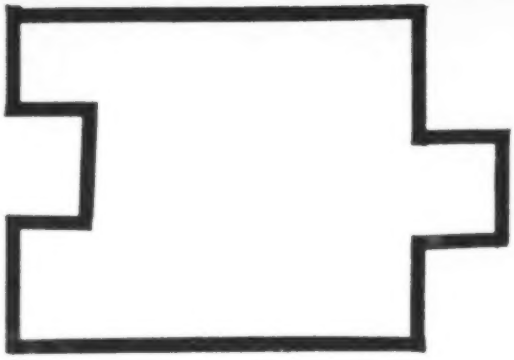

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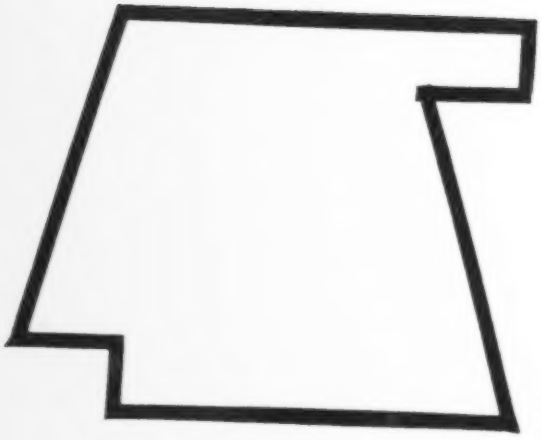

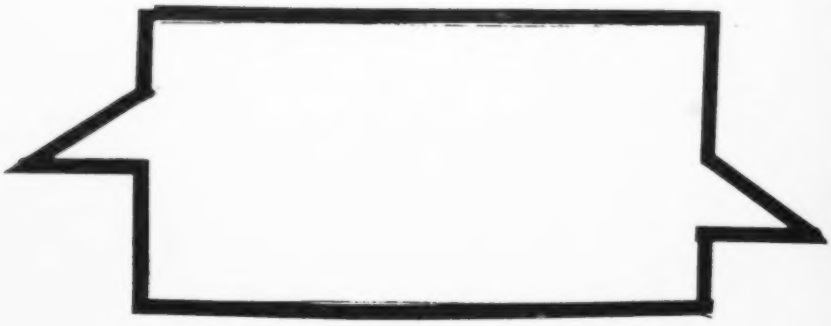

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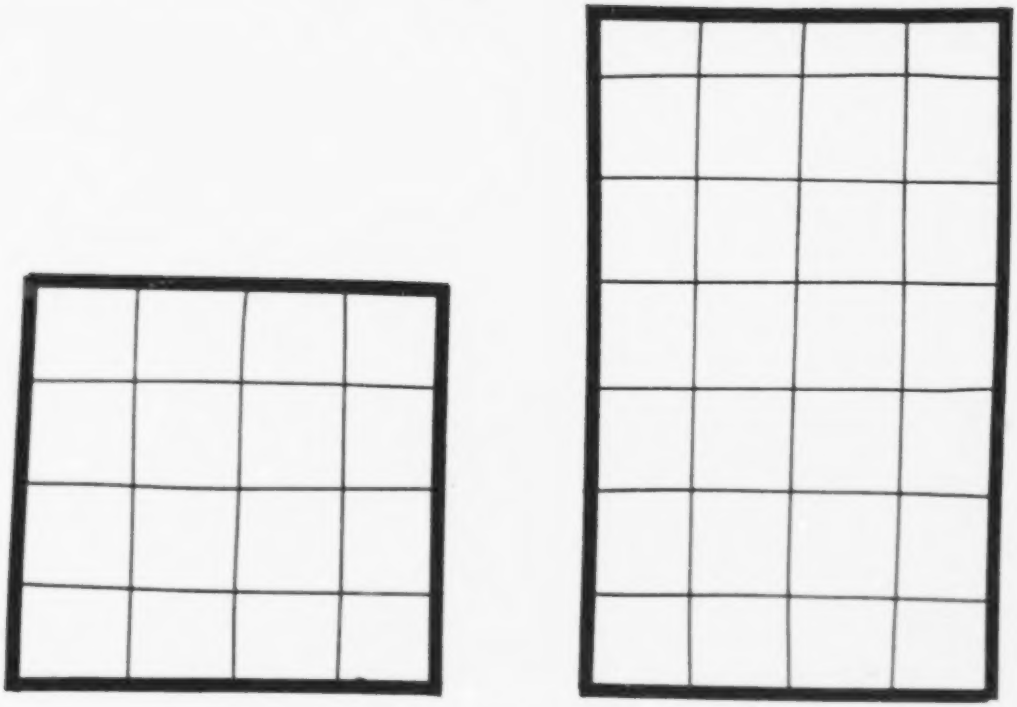

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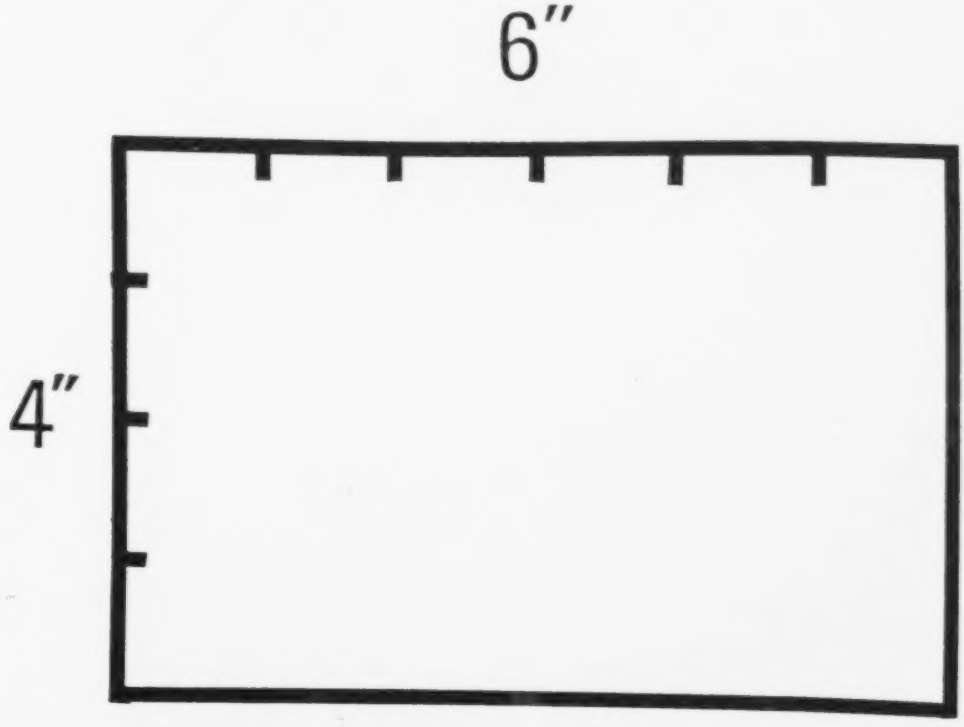

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